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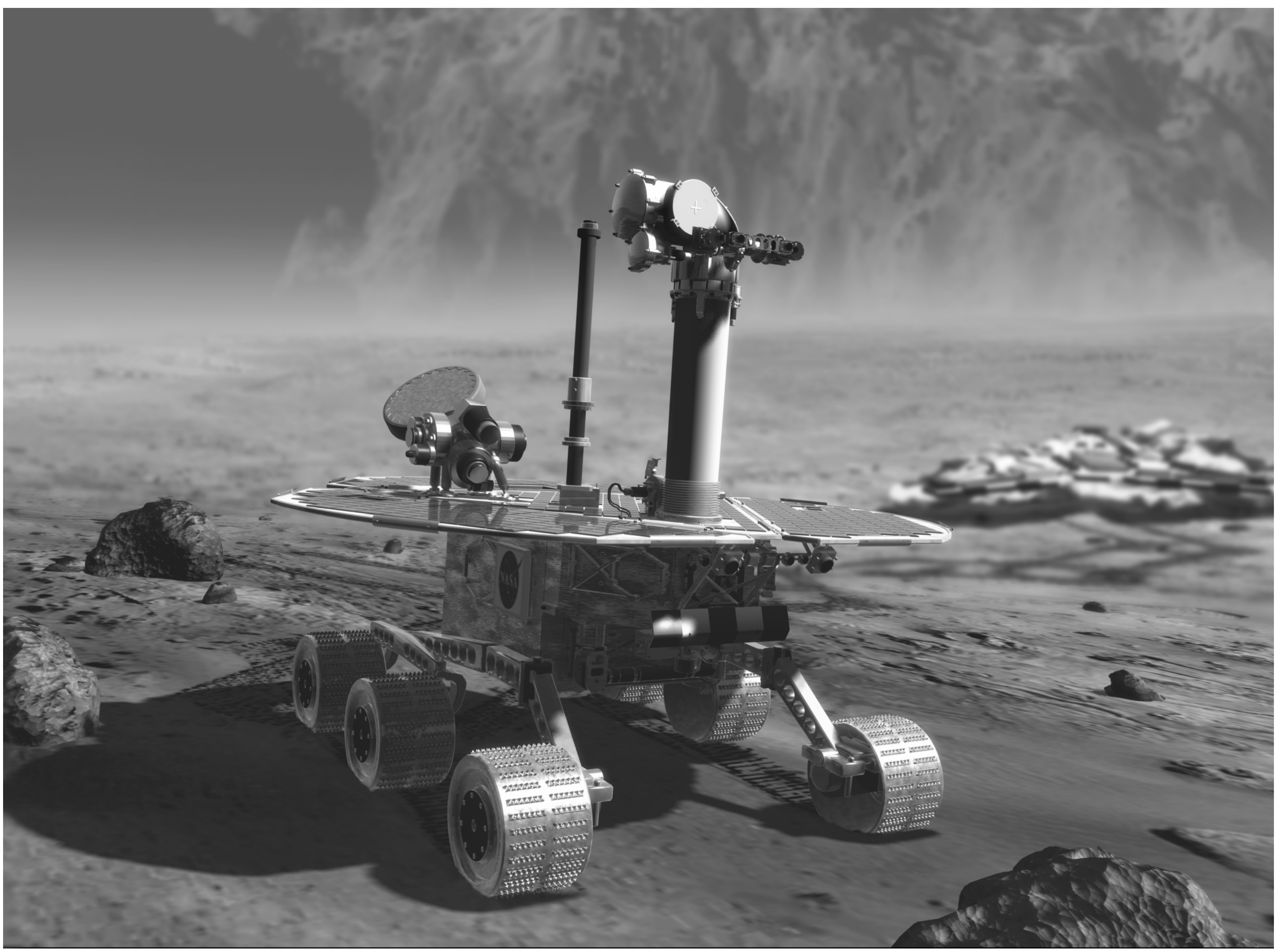
Final Environmental Impact Statement for the Mars Exploration Rover-2003 Project



FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR THE MARS EXPLORATION ROVER–2003 PROJECT

Office of Space Science
National Aeronautics and Space Administration
Washington, DC 20546

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FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE MARS EXPLORATION ROVER–2003 PROJECT

ABSTRACT

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This Final Environmental Impact Statement addresses the potential environmental impacts associated with continuing the preparations for and implementing the National Aeronautics and Space Administration's (NASA's) Mars Exploration Rover–2003 (MER–2003) project. As proposed, this project would continue the long-term exploration of Mars as part of the United States' solar system exploration effort. The 2003 launch opportunity represents the best opportunity for a surface mission to Mars in the next twenty years.

The Proposed Action for the MER–2003 project consists of two missions to send two identical mobile science laboratories (rovers) to the surface of Mars. A Delta II 7925 would be used to launch the first spacecraft during May or June 2003 from Cape Canaveral Air Force Station (CCAFS), Florida, and inject it into an Earth-Mars trajectory with arrival at Mars in January 2004. A Delta II 7925 Heavy would be used to launch the second spacecraft in June or July 2003 from CCAFS, and inject it into an Earth-Mars trajectory with arrival at Mars in January 2004. Under the No Action Alternative NASA would cease preparations for and not implement the MER–2003 project.

The potential environmental impacts of implementing the Proposed Action and the No Action Alternative were evaluated. The environmental impacts of preparations for and launch of the MER–2003 spacecraft under the Proposed Action would be limited to those environmental impacts associated with the normal launch of other Delta II launches from CCAFS and have been addressed in prior NASA and U.S. Air Force environmental documentation. These impacts would be primarily associated with the

exhaust products resulting from the launch vehicles' solid rocket motors and main engines. Expected environmental effects would include short-term impacts to air quality, vegetation, and wildlife at and near the launch pads, and short-term impacts to stratospheric ozone. There would be no environmental impacts associated with the No Action Alternative.

Also considered is the potential for launch accidents that may result in release of some of the radioactive material onboard each of the MER–2003 rovers. Each rover would be equipped with up to 11 radioisotope heater units (as a source of heat for the onboard electronics and batteries), and two science instruments containing small quantities of radioactive sources. Under the No Action Alternative, there would be no MER–2003 launches.

The U.S. Department of Energy (DOE), the owner of the radioisotope heater units, participates as a cooperating agency. DOE has prepared a detailed nuclear risk assessment of potential launch accidents and radiological consequences to human health and the environment, as well as estimates of the risks associated with each phase of each mission. DOE's risk assessment for the MER–2003 project indicates that both the likelihood of an accident resulting in a release of radioactive material, and the expected impacts of released radioactive material on or near the launch area, and on a global basis, would be small.

Implementation of the Proposed Action would accomplish all of the scientific and technical goals and objectives set forth for the MER–2003 project, and substantially further NASA's program for the exploration and understanding of Mars. The No Action Alternative would result in loss of the 2003 mission opportunity and would adversely impact attainment of NASA's long-term science objectives for the exploration of Mars.

EXECUTIVE SUMMARY

This Final Environmental Impact Statement (FEIS) for the Mars Exploration Rover–2003 project has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321 *et seq.*); Executive Order 12114, “Environmental Effects Abroad of Major Federal Actions”; the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR parts 1500-1508); and the National Aeronautics and Space Administration's (NASA's) policy and procedures (14 CFR subpart 1216.3). The purpose of this FEIS is to assist in the decisionmaking process concerning the Proposed Action and the No Action Alternative for the Mars Exploration Rover–2003 (MER–2003) project.

The MER–2003 project would consist of two missions to send two identical rovers to the surface of Mars to conduct mineralogy and geochemistry investigations and to characterize a diversity of rocks and soils which may hold clues about past water activity. Each rover would explore to a distance of at least 600 meters (1,968 feet) from its landing site, and surface operations would be expected to last at least 90 Martian days (sols[1]).

A Delta II 7925 with a Star 48B upper stage would be used to launch the first spacecraft (MER–A) during May or June 2003, and inject it into an Earth-Mars trajectory with arrival at Mars in January 2004. A Delta II 7925 Heavy (7925H) with a Star 48B upper stage would be used to launch the second spacecraft (MER–B) in June or July 2003, and inject it into an Earth-Mars trajectory with arrival at Mars in January 2004. NASA has not selected specific landing sites yet but is currently considering potential sites between 15° South and 5° North for the MER–A mission, and between 10° South and 10° North for the MER–B mission.

PURPOSE AND NEED FOR ACTION

For many years, Mars has been a primary focus for scientists due to its potential for past biological activity and for comparative studies with Earth. NASA continues to characterize the planet and its atmosphere, its geologic history, its climate and relationship to Earth's climate change process; to determine what resources Mars provides for future exploration; and to search for evidence of past or present life. The proposed MER–2003 missions would continue the exploration of Mars by enabling scientists to read the geologic record at each site, to investigate what role water played there, and to determine how suitable the conditions would have been for life. The scientific goal of each MER–2003 mission is to determine the aqueous, climatic, and geologic history of a site on Mars where conditions may have been favorable to the preservation of evidence of possible pre-biotic or biotic processes. The year 2003 represents a uniquely efficient launch opportunity for a surface mission to Mars in the next twenty years.

[1] 1 sol = 1 Martian day = 24 hours, 37 minutes or 1.026 Earth days

The science instrument suite carried on each MER–2003 rover would conduct a series of investigations of the Martian surface which are designed to shed new light on the past environments, history and geology of the planet. The project would conduct fundamentally new observations of Mars geology, including the first small-scale studies of rock samples, and a detailed study of surface environments for the purpose of calibrating and validating orbital spectroscopic remote sensing.

ALTERNATIVES EVALUATED

The Proposed Action consists of continuing preparations for and implementing the MER–2003 project to Mars. The MER–2003 project involves two launches (the MER–A mission and MER–B mission) of identical spacecraft from Cape Canaveral Air Force Station (CCAFS), Florida, in 2003. The MER–A launch, aboard a Delta II 7925, would occur during May or June, 2003. The MER–B launch would occur during June or July, 2003, aboard a Delta II 7925H. Programmatic issues (*e.g.*, changes in NASA priorities or unforeseen circumstances) could necessitate modification to the mission objectives and timing. Such modifications could result in the need to launch one mission in 2003, and a second mission at a later launch opportunity or not at all. Under the No Action Alternative NASA would cease preparations for and not implement the MER–2003 project.

The following section discusses the potential environmental impacts associated with implementation of the Proposed Action and the No Action Alternative. Because the Proposed Action would employ radioactive material that could potentially be released in the event of a launch vehicle accident, a discussion on potential radiological impacts is provided. This Executive Summary concludes with a brief evaluation of the MER–2003 project's science return, including the missions' implications for NASA's longer-term efforts to characterize Mars and answer fundamental questions regarding the planet.

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND THE NO ACTION ALTERNATIVE

Nonradiological Consequences of the Proposed Action and the No Action Alternative

For the MER–2003 project, the potentially affected environment includes the areas on and near the launch site at CCAFS in Florida. The potential environmental consequences of Delta II launch vehicles have been addressed in prior U.S. Air Force (USAF) and NASA NEPA documents, and are summarized below.

The environmental impacts of normal launches of the two missions for the Proposed Action would be associated principally with the exhaust emissions from each of the Delta II launch vehicles. These effects would include short-term impacts on air quality within the exhaust cloud at and near the launch pads, and the potential for acidic deposition on the vegetation and surface water bodies at and near each launch complex, particularly if rain occurs shortly after launch. Some short-term ozone degradation would occur along the flight paths as each launch vehicle passes through the stratosphere and deposits ozone-depleting chemicals from the solid rocket motors.

Accidents could occur during preparations for and launch of any launch vehicle. Only two types of nonradiological accidents would have potential off-site consequences: a liquid–propellant spill during fueling operations, and a launch failure. The most severe propellant spill accident scenario postulated involves release of the entire contents of the second stage nitrogen tetroxide (N_2O_4) tank during propellant transfer. Because N_2O_4 rapidly converts to nitrous oxides (NO_X) in the air, toxic effects of the release would be limited to the launch area.

A launch vehicle accident either on or near the launch pad within a few seconds of liftoff presents the greatest potential for impact to human health, principally to workers at the launch site. The potential short-term effects of an accident would include a localized fireball, falling fragments from explosion of the vehicle, release of uncombusted propellants and propellant combustion products, and for on-pad or very low altitude explosions, death or damage to nearby biota and brush fires near the launch pad.

There would be no environmental impacts associated with the No Action Alternative.

Radiological Consequences of Potential Launch Accidents for the Proposed Action and the No Action Alternative

Each MER–2003 rover could have up to 11 radioisotope heater units (RHUs), which use plutonium dioxide (consisting of mostly plutonium-238 (Pu-238)) to provide heat to prevent the electronics and batteries from freezing at night. The rover would also carry a small amount of radioactive sources (cobalt-57 (Co-57) and curium-244 (Cm-244)) in two of its science instruments. Depending on the sequence of events, some launch accidents could result in release of some of these materials.

NASA’s cooperating agency, the U.S. Department of Energy (DOE), as owner of the RHUs, has performed a nuclear safety risk assessment of potential accidents for the MER–2003 project. This assessment uses a methodology refined through applications to several previous missions and incorporates data from safety tests on the RHUs. The first step in the risk assessment is NASA's estimate of the probabilities of various launch system failures and the potential resulting accident environments that could threaten the RHUs and small-quantity radioactive sources onboard the spacecraft. Then, the response of the RHUs and small-quantity radioactive sources to these accident environments is assessed, and an estimate is made of the amount of radioactive material that could be released for each accident environment. Finally, the analysis determines the potential consequences of each release to the environment and to the population. Accidents are assessed over all launch phases, from pre-launch through orbit escape, and consequences are assessed for both the regional population near the launch site, and to the global population, in the event of an accident that results in a reentry from space.

DOE’s risk assessment for the MER–2003 project indicates that both the likelihood of an accident resulting in a release of radioactive material, and the expected impacts of released radioactive material on or near the launch area, and on a global basis, would be small.

The results of the NASA and DOE analyses indicate that the overall chance of an accident occurring during the launch of either of the MER–2003 spacecraft is about 1 in 30 (based upon launch vehicle history and additional analysis). Most potential accidents would not present a threat to the RHUs onboard the spacecraft because of the rugged design of the RHUs and the addition of an upper stage breakup system. For the MER–A launch, the chance of an accident in the launch area that releases any radioactivity is about 1 in 1,030. The overall chance of any accident that releases radioactive materials to the environment is about 1 in 230. The accident probabilities for a MER–B launch are similar.

The Cm-244 and Co-57 small-quantity radioactive sources and their mounting fixtures have relatively low melting temperatures compared to the plutonium in the RHUs, and their release in launch area accidents is assumed to be likely. Reentry conditions would also likely lead to the release of the small-quantity radioactive sources at high altitude. Safety testing and response analysis of the RHUs to accident environments indicate that only a very small fraction of early launch accidents could lead to potential releases of Pu-238. The RHUs are designed to survive reentry environments and subsequent surface impacts. The probability of an accident away from the launch area that could release small amounts of Cm-244 and Co-57, but not plutonium dioxide, is about 1 in 290.

The radiological consequences for each accident scenario were calculated in terms of (1) maximum individual dose; (2) potential for additional latent cancer fatalities (number of deaths due to cancer in excess of what the population would normally experience from other causes) due to a radiation release; and (3) land area contaminated at or above specified levels. Results are reported here for the MER–A mission. Results for the MER–B mission are similar.

If a launch-area accident resulting in the release of radioactive material were to occur, spectators and people offsite in the downwind direction could inhale small quantities of radionuclides, including Pu-238, Cm-244, and Co-57. In most cases, the amount of additional radiation exposure would be a very small fraction of the radiation exposure an individual receives from naturally occurring radiation in the Earth and from cosmic radiation. In the United States, the average annual radiation exposure is 300 millirem from natural background sources. Human-caused exposures such as medical diagnostic X-rays add an additional 60 millirem to this annual average. In the event of a launch accident with a release of radioactive materials, the person with the highest exposure would typically receive less than a few tens of millirem. No health consequences would be expected with this level of radiation exposure.

The total radiological exposure to the regional and global populations from an accidental release at high altitude would also be very small. With either launch-area or orbital reentry accidents, the releases are predicted to be so small that no additional cancers would be expected among the launch-area or worldwide population.

The airborne radioactive materials released in a launch-area accident would be deposited downwind from the accident location. Most of the material released in the accident scenarios considered would be very small particles. The results of the DOE analyses indicate that the land area contaminated at levels that might require further action, such as monitoring or cleanup, is expected to be less than 0.5 square kilometer (0.2 square mile) for postulated launch area accidents.

Under the No Action Alternative NASA would not complete preparations for and implement the MER–2003 project. The No Action Alternative would not entail any of the radiological risks associated with potential mission accidents.

SCIENCE COMPARISON

The Proposed Action would substantially further NASA's program for the exploration of Mars. The payload of instruments on each rover has been carefully selected to maximize collection of scientific data to meet MER–2003 project objectives. Scientists would be able to closely examine the physical, geological and chemical characteristics of the landing sites and determine their aqueous, climatic, and geologic histories. By reading the geologic record at each site, scientists would investigate the role water played there and determine how suitable the conditions might have been for life.

Operation of the rovers and their science instruments would also benefit the planning and design of future missions. Lessons learned during all phases of each MER–2003 mission (atmospheric entry, descent, and landing; initial deployment on the surface; real-time site traverse planning, execution and navigation; and science data collection) would provide valuable information for refining future mission designs and procedures.

Under the No Action Alternative none of the science planned for the MER–2003 missions would be obtained. The objectives of NASA's planned follow-on missions to Mars would be adversely affected without the data to be obtained by the MER–2003 missions.

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ABBREVIATIONS AND ACRONYMS

A

ac	acres
ADS	Automatic Destruct System
AEC	U.S. Atomic Energy Commission
AIC	accident initial condition
AOC	accident outcome condition
APXS	Alpha Particle X-ray Spectrometer
Al	aluminum
Al_2O_3	aluminum oxide

B

BUS	Breakup System (Star 48B)

C

^{o}C	degrees Celsius (centigrade)
CAA	Clean Air Act
CCAFS	Cape Canaveral Air Force Station
CDS	Command Destruct System
CFR	Code of Federal Regulations
Ci	curie(s)
Cl_2	chlorine
cm	centimeter(s)
Cm	curium
cm^2	square centimeters
Co	cobalt
CO	carbon monoxide
CO_2	carbon dioxide
COMPLEX	Committee on Planetary and Lunar Exploration

D

^{o}	degrees (temperature or angle)
dBA	decibels (A-weighted)
DEIS	Draft Environmental Impact Statement
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense

DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior

E

EA	environmental assessment
ECFRPC	East Central Florida Regional Planning Council
EDL	entry, descent and landing
EIS	environmental impact statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines

F

^{o}F	degrees Fahrenheit
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FEIS	Final Environmental Impact Statement
FR	*Federal Register*
FSII	full stack intact impact
ft	feet
ft^2	square feet
ft^3	cubic feet
FTS	Flight Termination System
FWS	U.S. Fish and Wildlife Service

G

g	gram(s)
gal	gallon(s)
GEM	graphite-epoxy solid rocket motor
GIS	Geographic Information System
GOAA	Greater Orlando Aviation Authority

H

H_2	hydrogen
H_2O	water
ha	hectare(s)
HCl	hydrochloric acid (hydrogen chloride)
HTPB	hydroxyl-terminated polybutadiene

I

IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IDD	Instrument Deployment Device
in	inch(es)
in^2	square inch(es)
in^3	cubic inch(es)
INSRP	Interagency Nuclear Safety Review Panel
ISDS	Inadvertent Separation Destruct System

J

JPL	Jet Propulsion Laboratory, California Institute of Technology

K

K	degrees Kelvin
KeV	kilo electron volt(s)
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
km/s	kilometers per second
KSC	Kennedy Space Center, NASA

L

lb	pound(s)
lbf	pound(s)-force
LDXL	Large Diameter Extra Long (GEM)
LOX	liquid oxygen

M

m	meter(s)
m^3	cubic meter(s)
mCi	millicurie(s)
MECO	main engine cutoff
MER–2003	Mars Exploration Rover–2003
MET	mission elapsed time
MFCO	Mission Flight Control Officer
MGS	Mars Global Surveyor

mi	mile(s)
mi^2	square mile(s)
MINWR	Merritt Island National Wildlife Refuge
mm	millimeter(s)
MMH	monomethyl hydrazine
mph	miles per hour
mt	metric ton(s)
µCi	microcurie(s)
$\mu Ci/m^2$	microcurie(s) per square meter
$\mu g/m^2$	microgram(s) per square meter
$\mu g/m^3$	microgram(s) per cubic meter

N

N_2	nitrogen
N_2H_4	hydrazine
N_2O	nitrous oxide
N_2O_4	nitrogen tetroxide (NTO)
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NCRP	National Council on Radiation Protection
NEPA	National Environmental Policy Act
nmi	nautical mile(s)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOI	notice of intent
NRC	U.S. Nuclear Regulatory Commission

O

O_2	oxygen
O_3	ozone
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
oz	ounce(s)

P

Pancam	Panoramic Camera
pfs	pounds per square foot
pH	measure of acidity
PLF	payload fairing
PMA	Pancam Mast Assembly
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
PM_{10}	particulate matter less than 10 microns in diameter
ppm	parts per million
Pu	plutonium
PuO_2	plutonium dioxide

R

REEDM	Rocket Exhaust Effluent Diffusion Model
rem	roentgen equivalent man
RHU	radioisotope heater unit
RP-1	rocket propellant–1
RTG	Radioisotope Thermoelectric Generator

S

s	second(s)
SECO	second-stage engine cutoff
SFWMD	South Florida Water Management District
SJRWMD	St. Johns River Water Management District
SLC	Space Launch Complex
SNAP	Systems for Nuclear Auxiliary Power
SO_2	sulfur dioxide
SPEGL	Short-Term Public Emergency Guidance Level
SR	State Route
SSB	Space Studies Board

T

T	time
TECO	Third-stage engine cutoff
TES	Thermal Emission Spectrometer

U

UDMH	unsymmetrical dimethylhydrazine
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
USAF	U.S. Air Force
USBC	U.S. Bureau of the Census
U.S.C.	U.S. Code

W

WEB	warm electronics box

CONVERSION FACTORS

Length	
1 centimeter (cm) = 0.3937 inch (in)	1 inch = 2.54 cm
1 centimeter = 0.0328 foot (ft)	1 foot = 30.48 cm
1 meter (m) = 3.2808 feet	1 ft = 0.3048 m
1 meter = 0.0006 mile (mi)	1 mi = 1609.3440 m
1 kilometer (km) = 0.6214 mile	1 mi = 1.6093 km
1 kilometer = 0.53996 nautical mile (nmi)	1 nmi = 1.8520 km
	1 mi = 0.87 nmi
	1 nmi = 1.15 mi
Area	
1 square kilometer (km^2) = 0.3861 square mile (mi^2)	1 mi^2 = 2.5900 km^2
1 hectare (ha) = 2.4710 acres (ac)	1 ac = 0.4047 ha
Volume	
1 liter = 0.2642 gallon (gal)	1 gal = 3.7854 l
Weight	
1 gram (g) = 0.0353 ounce (oz)	1 oz = 28.3495 g
1 kilogram (kg) = 2.2046 pounds (lb)	1 lb = 0.4536 kg
1 metric ton (mt) = 1.1023 tons	1 ton = 0.9072 metric ton

1 PURPOSE AND NEED FOR ACTION

This Final Environmental Impact Statement (FEIS) has been prepared by the National Aeronautics and Space Administration (NASA) to assist in the decisionmaking process as required by the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321 *et seq.*); Executive Order (EO) 12114, "Environmental Effects Abroad of Major Federal Actions"; Council on Environmental Quality Regulations (40 CFR parts 1500–1508); and NASA policies and procedures at 14 CFR subpart 1216.3. This FEIS provides information associated with potential environmental impacts of continuing preparations for and implementing the proposed Mars Exploration Rover–2003 (MER–2003) project. The U.S. Department of Energy (DOE), as a cooperating agency, performed a nuclear safety risk assessment of potential accidents for the MER–2003 project. The MER–2003 project would conduct scientific investigations on the surface of Mars. The project would consist of two launches in 2003 of identical MER–2003 spacecraft (the MER–A mission and the MER–B mission) from Cape Canaveral Air Force Station (CCAFS), Florida. Chapter 2 of this FEIS evaluates the alternatives considered for the MER–2003 project.

1.1 BACKGROUND

The missions of the proposed MER–2003 project would be part of NASA's program for the exploration of the solar system. The goals of this program include understanding the nature and history of our solar system, and what makes Earth similar to and different from its planetary neighbors; understanding the origin and evolution of life on Earth; and understanding the external forces that affect life and the habitability of Earth. Interwoven with these goals is the search for and study of life elsewhere in the Universe. Over the past three decades NASA has addressed these goals with increasingly sophisticated robotic missions to the other planets and minor bodies of the solar system. The MER–2003 missions would continue the more detailed exploration of our nearest neighbor, the planet Mars.

Mars is a rocky planet like Earth but is substantially smaller with a thinner atmosphere and a cold, desert surface. As a result of previous space missions (the early Mariner Mars flybys and orbiter, the Viking orbiters and landers, the Mars Pathfinder lander and rover, and the Mars Global Surveyor (MGS) orbiter), much more has already been learned about Mars compared to any of the other planetary bodies except for the Moon. Meteorites that came from Mars have been found on Earth. Some of these meteorites are very young. One Mars meteorite, collected in Antarctica, is ancient, however, and has stimulated scientific controversy regarding possible evidence of fossil microbial life seen in the meteorite.

Mars has had a complicated history in which, among many geologic processes, liquid water may have played a major role in shaping the surface. Evidence of geologically recent volcanism has been observed, indicating that Mars may still be active. Mars is suspected to still have a significant quantity of subsurface water in the form of ground ice at and near the surface and in the liquid phase at greater depths. The early Martian surface environment may have been much more suitable for the evolution of life than would be supposed by observing the thin, dry atmosphere and the cold, unprotected (from solar ultra-violet radiation) surface of present-day Mars.

Many of the scientific questions regarding Mars ultimately involve the role and fate of the water that once flowed on its surface. Accordingly, NASA has developed an exploration strategy which can be summarized as "Follow the Water".

The reason for the intense interest in Martian water is simple: without water, life cannot exist as we know it. If it has been billions of years since liquid water was present on Mars, the chance of finding life there now is remote. But if water is present on Mars now, however well hidden, life may be holding on in some protected niche.

Based on what we have observed so far, Mars today is a frozen desert. The climate is too cold for liquid water to exist on the surface and it is too cold to rain. The planet's atmosphere is also too thin to permit any significant amount of snowfall. Even if some internal heat source warmed the planet enough for ice to melt, it would not yield liquid water. The Martian atmosphere is so thin that even if the temperature rose above freezing the ice would change directly to water vapor.

Despite these observations, there may have been abundant water in Mars' past. That is evident from the massive outflow channels that are found, mostly, in the northern lowlands of Mars. The intensity of the floods that carved these channels would have been tremendous. This evidence leads to several intriguing scientific questions, beginning with what caused these giant floods? Were the floods a result of a climate change, perhaps brought about by a change in the orbit of Mars, or was the planet's own internal heat responsible? Whatever the mechanism that caused the floods in the first place, where has all that water gone? Was it absorbed into the ground where it remains today, frozen? Or did it dissipate into the Martian atmosphere, where it was subsequently lost to space? No one knows for certain the answers to these questions.

1.2 PURPOSE OF THE ACTION

The purpose of the action addressed in this FEIS is to further the scientific objectives of NASA's program for solar system exploration by continuing the exploration and characterization of Mars. Specifically, the MER–2003 missions proposed for launch would continue the intensive and extensive study of two different local areas of the planet. These studies would involve geological investigations of two geologically different areas and characterize a diversity of rocks and soils which may hold clues to past water activity.

The scientific goal of each MER–2003 mission is to determine the aqueous, climatic, and geologic history of a site on Mars where conditions may have been favorable to the preservation of evidence of possible pre-biotic or biotic processes. Accordingly, the MER–2003 rovers would land on two pre-selected sites that show evidence of the action of liquid water. The broad scientific objectives for each mission are to:

- identify the hydrologic, hydrothermal, and other processes that have operated at the landing site and affected the materials there, using measurements of their mineralogy, elemental chemistry, and surface texture;

- identify and investigate Martian rocks and soils that have the highest possible chance of preserving evidence of ancient environmental conditions and possible pre-biotic or biotic activity; and,
- use the tools that were designed for the above objectives to respond to other discoveries associated with rover-based exploration.

The MER–2003 missions encompassed by the Proposed Action would continue the exploration of Mars by enabling scientists to read the geologic record at each site, to investigate what role water played there, and to determine how suitable the conditions would have been for life.

The proposed MER–2003 missions would also take advantage of one of the most efficient launch opportunities to place landers on the surface of Mars. During 2003, the planetary alignments are such that NASA has the opportunity to use smaller, less expensive launch vehicles to deliver a payload to the surface of Mars. NASA proposes to take advantage of this opportunity, within the limits of available resources, to launch two rovers to Mars. The Proposed Action would allow NASA to substantially advance its technological and operational capabilities on the surface of Mars. NASA established mission-level objectives including, but not limited to:

- demonstrate long range traverse capabilities by mobile science platforms to validate long-lived, long distance rover technologies;
- demonstrate complex science operations through the simultaneous use of multiple science-focused mobile laboratories; and
- validate the standards, protocols, and capabilities of the international Mars communications infrastructure.

1.3 NEED FOR THE ACTION

Following the water means looking for scientific evidence that water was present in the past or is present today on Mars, either below the surface or possibly in rare locations near small, hydrothermal vents. Previous and current Mars missions have returned views of the Martian surface that seem to show evidence of dry riverbeds, flood plains, rare gullies on Martian cliffs and crater walls, and sedimentary deposits that suggest the presence of water in the history of Mars.

A recent study by the Committee on Planetary and Lunar Exploration (COMPLEX) of the National Research Council's Space Studies Board (SSB) considered the scientific rationale for mobility in conducting planetary exploration (SSB 1999). In this study, COMPLEX concluded, in part, that "The pattern of planetary exploration to date has been to make basic observations of planetary surfaces from orbiters and to establish hypotheses for interpreting these observations. These hypotheses are then tested by more directed observations and measurements. Because the hypotheses are based on orbital images with a relatively low characteristic resolution, this suggests that long-range traverses are required to test the relevant hypotheses."

Regarding the need for mobility on the surface of Mars, COMPLEX further stated that "Although the global- and regional-scale surveys of mineralogic and elemental compositions that are a prerequisite for any assessment of Mars's potential as an abode of life can be determined from orbit, the detailed characterization of local sites of particular exobiological interest requires *in situ* (local) measurements. Most researchers do not expect that evidence for past or present life will be so abundant or widespread that it will be available in the immediate vicinity of landing sites. This is particularly true given that landings may occur up to tens of kilometers from the desired aim point. Without the mobility necessary to conduct *in situ* exploration, it may not be possible to identify a target location uniquely."

The MER–2003 missions encompassed by the Proposed Action would provide the capability for much greater mobility on the surface of Mars than ever before. Using a coordinated and complementary suite of scientific investigations, the MER–2003 rovers would explore broad areas around two diverse landing sites, searching for evidence of past or current water activity.

1.4 NEPA PLANNING AND SCOPING ACTIVITIES

On February 22, 2001, NASA published a Notice of Intent (NOI) in the *Federal Register* (66 FR 11184) to prepare an Environmental Impact Statement and conduct scoping for the Mars Exploration Rover–2003 Project. The scoping period ended April 9, 2001. Two scoping comments were received from private individuals expressing concerns about the use of plutonium in space missions, and were considered in development of the Draft Environmental Impact Statement (DEIS).

1.5 RESULTS OF PUBLIC REVIEW OF THE DRAFT EIS

NASA published its Notice of Availability for the DEIS for the Mars Exploration Rover–2003 Project on July 24, 2002 (67 FR 48490), and mailed copies to 79 Federal, State and local agencies, organizations, and individuals. In addition, the DEIS was publicly available in electronic format from a NASA server on the Internet. The U.S. Environmental Protection Agency published its Notice of Availability on July 26, 2002 (67 FR 48894), initiating the 45-day review and comment period.

The comment period for the DEIS closed on September 9, 2002. Responses were received from a total of four Federal and State entities (the State of Florida response consolidated the reviews of several State agencies), and two individuals. The comments included "no comment", requests to clarify specific points of discussion in the text, and an objection to the use of nuclear material in space. Minor clarifying revisions have been made as a result of the comments. All communications received during the DEIS public review period are found in Appendix C of this FEIS.